



# The Effect of Individual Characteristics, Physical Activity, and Consumption of Sweetened Foods and Drinks on the Incidence of Type 2 Diabetes Mellitus in Adults Aged 30–60 Years in Medan

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***Abstract***

*The Sustainable Development Goals (SDGs) aim to reduce morbidity and mortality from non-communicable diseases, including diabetes mellitus, by 2030. Around 8.5 percent of adults worldwide are living with of type 2 diabetes mellitus, and up to 1.5 million people die from it. The prevalence of diabetes mellitus in Indonesia was 2 percent in 2018, and in North Sumatera was 249.519 cases with the highest number of cases in Medan City. This increase in diabetes mellitus prevalence is associated with several risk factors. This study aims to analyze the effect of individual characteristics, physical activity, and consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus in 30–60 years age group in Medan. This type of research was observational analytic used a case control design. This study was conducted in 6 community health centers with the highest number of diabetes cases divided into 3 sub-districts with the highest number of type 2 diabetes mellitus cases. This study was conducted from February to October 2023. The sampling technique uses purposive sampling. The population in this study were people 30-60 years age group in Medan with sample size of 66 cases and 66 controls. Logistic regression was used for data analysis. The results showed that there was an effect between age (p=0.002), physical activity (p=0.034), consumption of sweetened foods and drinks (p=<0.001), and family history (p=<0.001) on the incidence of type 2 diabetes mellitus. The community is expected to do regular physical activity of at least 150 minutes per week, limit sugar intake every day, and conduct regular health checks if they know the family health history that contributes to the development of type 2 diabetes mellitus.*

***Keywords: Diabetes, Drinks, Foods , Physical Activity, Sweetened***

## INTRODUCTION

The Sustainable Development Goals (SDGs), as part of the 2030 plan, aim to reduce premature deaths from non-communicable diseases by one-third through prevention and optimal treatment (WHO, 2017). Non-communicable diseases have caused the deaths of 41 million people each year, or 71 percent of all deaths worldwide. More than 15 million people in the 30–50 age group die from non-communicable diseases, including of type 2 diabetes mellitus (WHO, 2022).

Type 2 diabetes mellitus is a metabolic disorder characterized by elevated blood glucose levels due to insulin abnormalities. Some of the symptoms are polyuria (frequent urination), polydipsia (frequent thirst) and polyphagia (excessive hunger), blurred vision, impaired body movement, tingling in the feet and hands, pruritus and unexplained weight loss (Marselin et al., 2021). The World Health Organization (WHO) in 2019 showed that around 8.5 percent of adults worldwide have of type 2 diabetes mellitus and up to 1.5 million people

die from diabetes mellitus, with 48 percent of most cases dying before the age of 70 (WHO, 2021). According to the International Diabetes Federation (IDF) in 2021 537 million adults were living with diabetes and 783 million people died because of it (IDF, 2021)

In Indonesia, diabetes prevalence based on physician diagnosis of the population over 15 years old is 2 percent, up from 1.3 percent in 2013 (Kemenkes RI, 2018). The prevalence of diabetes mellitus in North Sumatra in 2019 was 249,519 cases, with only 144,521 patients receiving health care services (Dinas Kesehatan Sumatera Utara, 2019). Medan City has the highest number of type 2 diabetes mellitus cases in North Sumatra Province with 40,609 cases during 2022.

Diabetes mellitus has many risk factors that contribute to its development, which can be divided into non-modifiable risk factors (age, race, ethnicity, gender and history of low birth weight) and modifiable risk factors related to lifestyle (unhealthy diet, smoking, obesity, hypertension, and dyslipidemia) (Kementerian Kesehatan RI., 2020). Besides the risk factors mentioned above, physical activity, consumption of sweetened foods and drinks, and a family history of type 2 diabetes mellitus are also linked to an increased risk of type diabetes mellitus. Research conducted at Muhammadiyah General Hospital in North Sumatra showed that individuals who have less than 3 times a week physical activity have a 3.13 times higher risk of developing type 2 diabetes mellitus compared to individuals with physical activity more than 3 times a week, and also that individuals who have a family history of type 2 diabetes mellitus are 4.62 times more likely to develop type 2 diabetes mellitus than those without (Nasution, 2018). Another study conducted in Medan City in 2021 also found that frequent consumption of sweetened foods and drinks was one of the risk factors contributing to an increase in the incidence of type 2 diabetes mellitus (Siregar et al., 2021).

Diabetes mellitus is a non-communicable disease that is still a health problem both in the world and in Indonesia. The estimated cases of diabetes mellitus in Medan City have increased from 6.661 cases in 2021 to 21.515 cases of diabetes in 2022. There are six sub-districts that can represent the number of people with type 2 diabetes mellitus in Medan City, which are divided into three sub-districts with the highest number of diabetes mellitus cases, namely Medan Tuntungan, East Medan and South Medan Area, and three sub-districts with the lowest number of diabetes mellitus cases, namely Medan Maimun, Medan Amplas and Medan Selayang. Based on the results of the preliminary survey of the research conducted, it shows that out of a total of 30 respondents, 17 respondents suffered from type 2 diabetes mellitus and 13 respondents did not suffer from type 2 diabetes mellitus. Through interviews with 17 respondents suffering from type 2 diabetes mellitus, 14 respondents (82.4%) did not

do sports activities, 16 respondents (94.1%) had a habit of consuming sweet foods and drinks and 13 respondents (76.5%) had a family history of type 2 diabetes mellitus.

Diabetes mellitus leads to many complications that have an impact not only on the health sector but also on the economic system of the country, so it is necessary to identify risk factors and prevent them. Controlling the risk factors of diabetes mellitus needs to be done to prevent the increasing incidence of type 2 diabetes mellitus. Based on this background, this study aimed to analyze the effect of individual characteristics, physical activity, and consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus in adults aged 30-60 years in Medan.

## METHODS

This type of research is an observational analytical epidemiological research using case-control study design. The selection of the research location was done purposively based on the researcher's consideration. This study was conducted in 6 community health centers with the highest number of diabetes cases divided into 3 sub-districts with the highest number of type 2 diabetes mellitus cases, namely Medan Tuntungan (Tuntungan community health centers), Medan Timur (Glugur Darat community health centers), and Medan Area Selatan (Medan Area Selatan community health centers ), and 3 sub-districts with the lowest number of diabetes mellitus cases in 2022, namely Medan Maimun (Kampung Baru community health centers), Medan Amplas (Amplas community health centers), and Medan Selayang (Medan Selayang II community health centers). This study was conducted from February to October 2023. The sampling technique uses purposive sampling under determined inclusion and exclusion criteria.

The population in this study were all adults aged 30-60 years in Medan City which totals 1.048.365 people. The sample consisted of a total of 132 respondents divided into 66 cases and 66 control subjects. Case inclusion criteria were patients with newly diagnosed type 2 diabetes by a doctor within the last 3 months and recorded in the medical record. Exclusion criteria for cases were patients with type 1 diabetes mellitus, gestational diabetes mellitus, and other types of diabetes mellitus. The inclusion criteria for controls were all respondents who did not suffer from diabetes mellitus and had a blood sugar level below 200 mg/dL, while the exclusion criteria for controls were individuals who were mentally impaired and unable to communicate well. Case and control samples who are agreed to participate in this study must sign an informed consent.

Data were collected by interview using an International Physical Activity Questionnaire (IPAQ) to measure physical activity and other questionnaires to individual characteristic (age

and family history) determine the consumption of sweetened foods and drinks and family history of diabetes mellitus. The data were processed using Statistical Package for Social Science (SPSS), version 25.0. Descriptive analysis was used to determine the frequency and distribution of respondent characteristics. The effect of individual characteristics, physical activity and consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus was analyzed in bivariate using simple logistic regression and in multivariate using multiple logistic regression. This research has gone through ethical trials from the Health Research Ethics Committee of the Universitas Sumatera Utara by number 889/KEPK/USU/2023.

## RESULTS

Based on the data collection from 66 cases and controls each, the results are described in the following table:

**Table 1 Frequency Distribution of Respondents Based on Sociodemographic Characteristics**

| Sociodemographic Characteristics | Cases | | Controls | |
|---|---|---|---|---|
| | n = 66 | % | n = 66 | % |
| **Gender** | | | | |
| Male | 29 | 43.9 | 27 | 40.9 |
| Female | 37 | 56.1 | 39 | 59.1 |
| **Education** | | | | |
| Elementary school | 5 | 7.6 | 5 | 7.6 |
| Junior high school | 5 | 7.6 | 4 | 6.1 |
| Senior high school | 35 | 53.0 | 43 | 65.2 |
| University | 21 | 31.8 | 14 | 21.2 |
| **Occupation** | | | | |
| Housewife | 22 | 33.3 | 31 | 47.0 |
| Government employees | 4 | 6.1 | 2 | 3.0 |
| Private employees | 3 | 4.5 | 3 | 4.5 |
| Entrepreneur | 27 | 40.9 | 24 | 36.4 |
| Farmer | 2 | 3.0 | 0 | 0 |
| Laborer, driver, household assistant | 2 | 3.0 | 3 | 4.5 |
| Others | 6 | 9.1 | 3 | 4.5 |
| **Income** | | | | |
| Low (<3,624,117.59 IDR) | 41 | 62.1 | 50 | 75.8 |
| High (≥3,624,117.59 IDR) | 25 | 37.9 | 16 | 24.2 |

Based on Table 1 above, the majority of respondents based on gender in the case group were female, that is, 37 people (56.1%). The majority of respondents in the control group were also female, namely 39 people (59.1%). Furthermore, the majority of respondents in the case group had a high school education, namely 35 people (53.0%), and in the control group, the majority of respondents also had a high school education, namely 43 people (65.2%). In terms of occupation, the majority of respondents in the case group worked as entrepreneur, namely 27 people (40.9%), and in the control group the majority of respondents worked as housewives, namely 31 people (47.0%). In terms of income level, the majority of respondents in the case

group had a low income or below the Medan City minimum wage (<3,624,117.59 IDR), namely 41 people (62.1%), and the majority of respondents in the control group also had a low income or below the Medan City minimum wage (<3,624,117.59 IDR), namely 50 people (75.8%).

**Table 2 Frequency Distribution of Respondents Based on Variables**

| Variables | Cases | | Controls | |
|---|---|---|---|---|
| | n = 66 | % | n = 66 | % |
| **Age** | | | | |
| ≤45 years | 9 | 13.6 | 25 | 37.9 |
| >45 years | 57 | 86.4 | 41 | 62.1 |
| **Family History of type 2 diabetes mellitus** | | | | |
| Yes | 37 | 56.1 | 14 | 21.2 |
| No | 29 | 43.9 | 52 | 78.8 |
| **Physical Activity** | | | | |
| Insufficient (Low) | 46 | 69.7 | 34 | 51.5 |
| Sufficient (Moderate–High) | 20 | 30.3 | 32 | 48.5 |
| **Consumption of Sweetened Foods and Drinks** | | | | |
| At Risk (> 5 g/day) | 55 | 83.3 | 29 | 43.9 |
| Not At Risk (≤ 5 g/day) | 11 | 16.7 | 37 | 56.1 |

Table 2 above shows that the majority of respondents based on age in the case group were over 45 years old, namely 57 people (86.4%) and the majority of respondents in the control group were over 45 years old, namely 41 people (62.1%). There were more respondents with a family history of type 2 diabetes mellitus in the case group, namely 37 people (56.1%), whereas in the control group the majority of respondents did not have a family history of type 2 diabetes mellitus , namely 52 people (78.8%). The majority of respondents in the case group had insufficient (low level) physical activity, namely 46 people (69.7%), and in the control group the majority of respondents also had a low level of physical activity, namely 34 people (51.5%). There were more respondents at-risk due to consumption of sweetened foods and drinks in the case group, namely 55 people (83.3%), whereas the majority of respondents in the control group had no habit of consuming sweetened foods and drinks, namely 37 people (56.1%).

**Table 3 Frequency Distribution of Respondents Based on Physical Activity and Consumption of Sweetened Foods and Drinks**

| Variables | Consumption Sweetened Foods/Drinks | | | |
|---|---|---|---|---|
| | Yes | | No | |
| | n | % | n | % |
| Physical Activity | | | | |
| Insufficient (Low) | 55 | 41.7 | 25 | 18.9 |
| Sufficient (Moderate–High) | 29 | 22.0 | 23 | 17.4 |

Table 3 above shows that most of those who have a habit of consuming sweetened foods and drinks also have insufficient (low level) physical activity, namely 55 people (41.7%), while

the proportion of respondents who are sufficiently physically active with no habit of consuming sweetened foods and drinks is only 23 people (17.4%).

**Table 4 Bivariate Analysis Results Using Simple Logistic Regression**

| Variables | p-value | OR | 95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **Age** | | | | |
| ≤45 years<br>>45 years | 0.002 | 3.862 | 1.632 | 9.137 |
| **Family History of type 2 diabetes mellitus** | | | | |
| Yes<br>No | <0.001 | 4.739 | 2.206 | 10.179 |
| **Physical Activity** | | | | |
| Insufficient (Low)<br>Sufficient (Moderate–High) | 0.034 | 2.165 | 1.061 | 4.417 |
| **Consumption of Sweetened Foods and Drinks** | | | | |
| At–Risk (> 5 g/day)<br>Not At–Risk (≤ 5 g/day) | <0.001 | 6.379 | 2.839 | 14.334 |

Based on the results of bivariate analysis in Table 4, it was found that the variables of age, family history, physical activity, and consumption of sweetened foods and drinks had a significant effect on the incidence of type 2 diabetes mellitus with a p–value <0.05. Respondents aged over 45 years had a 3.862 times greater risk of developing type 2 diabetes mellitus than respondents aged 45 years and younger and respondents with a family history of type 2 diabetes mellitus had a 4.739 times higher risk of developing type 2 diabetes mellitus compared with respondents without a family history of type 2 diabetes mellitus.

Also, respondents with a low level of physical activity had a 2.165 times higher risk of developing type 2 diabetes mellitus compared to respondents with sufficient (moderate–high level) physical activity. Respondents who had a habit of consuming sweetened foods and drinks had a 6.379 times greater risk of developing type 2 diabetes mellitus than those without a habit of consuming sweetened foods and drinks.

**Table 5 Results of Multivariate Analysis Using Multiple Logistic Regression**

| Step | Variables | Coefficient (B) | p | OR | 95% CI | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Step 1[a] | Age | 1.291 | 0.013 | 3.638 | 1.310 | 10.104 |
| | Family history of type 2 diabetes mellitus | 1.579 | 0.001 | 4.850 | 1.976 | 11.907 |
| | Physical activity | 0.525 | 0.243 | 1.691 | 0.700 | 4.086 |
| | Consumption of sweetened food and drinks | 1.987 | 0.000 | 7.291 | 2.858 | 18.601 |
| | Constant | –3.226 | 0.000 | 0.040 | | |
| Step 2[a] | Age | 1.239 | 0.015 | 3.453 | 1.270 | 9.387 |
| | Family history of type 2 diabetes mellitus | 1.676 | <0.001 | 5.320 | 2.183 | 12.964 |
| | Consumption of sweetened food and drinks | 2.005 | <0.001 | 7.425 | 2.942 | 18.740 |
| | Constant | –2.889 | <0.001 | 0.056 | | |

Based on the final results of the last step of multivariate analysis using multiple logistic regression by testing the effect of independent variables simultaneously on the dependent variable, it was found that age, family history, and consumption of sweetened foods and drinks affected the incidence of type 2 diabetes mellitus with a p–value of less than 0.05. through multivariate analysis, it can be seen that the most dominant variable affecting the incidence of type 2 diabetes mellitus in adults aged 30–60 years in Medan is consumption of sweetened foods and drinks with an OR value of 7.425. This indicates that respondents who have the habit of consuming sweetened foods and drinks have a 7.425 times higher risk of developing type 2 diabetes mellitus compared to respondents without a habit of consuming sweetened foods and drinks.

## DISCUSSION

### The Effect of Age on the Incidence of Type 2 Diabetes Mellitus in Adults Aged 30–60 Years in Medan

The results of bivariate analysis using simple logistic regression showed that in this study there was a significant effect between age on the incidence of type 2 diabetes mellitus in adults aged 30-60 years in Medan ($p=0.002$; $p<0.05$). This is relevant to the result of research conducted by Pangestika et al. (2021) at the Talang Ubi General Hospital of Pali District which shows that individuals aged over 45 years have a greater risk of developing type 2 diabetes mellitus than individuals aged 45 years and younger ($p=0.001$; $p<0.05$).

Another study conducted by Novita et al. (2018) at the Talang Bakung Village in Jambi City also showed that individuals aged >45 years had a 4.97 times higher risk of suffering from type 2 diabetes mellitus than individuals aged ≤45 years (OR=4.97; 95% CI=1.39–17.82; $p<0.05$). Furthermore, research by Kabosu et al. (2017) at Bhayangkara Hospital, Kupang showed that individuals aged over 45 years had a 3.544 times higher risk of developing type 2 diabetes mellitus than individuals aged ≤45 years (OR=3.544; 95% CI=1.337–9.389; $p<0.05$).

Age is one of the non-modifiable risk factors for type 2 diabetes mellitus. Individuals aged over 45 years old have an increased risk of developing type 2 diabetes mellitus and glucose intolerance due to degenerative factors, particularly impaired body function in glucose metabolism (PERKENI, 2021). At the age of more than 45 years, the body undergoes anatomical, physiological, and biochemical changes, first at the cellular level, then in the body tissues and organs, which can affect the process of maintaining the stability of the human body. In people over the age of 30 years, blood glucose levels will rise by about 1-2 percent 2 hours after eating (Damayanti, 2017).

According to the American Association of Clinical Endocrinologists, the prevalence of type 2 diabetes mellitus is increasing in the population aged 30 years and above (Dany et al., 2017). The aging process results in glucose intolerance due to decreased function of pancreatic beta cells, and decreased insulin sensitivity due to increased fat, decreased physical activity, hormonal changes and increased oxidative stress and inflammation (Safiri et al., 2022).

Based on the explanation above, the researchers assume that there is a relationship between age with type 2 diabetes mellitus, because decreased body function including pancreatic B-cell function which increases the risk of glucose intolerance. This can be seen from the majority of respondents based on age in the case group were more than 45 years old, namely 57 people (86.4%).

**The Effect of Family History on the Incidence of Type 2 Diabetes Mellitus in Adults Aged 30–60 Years in Medan**

The results of this study also showed that there was a significant effect between family history of type 2 diabetes mellitus on the incidence of type 2 diabetes mellitus ($p=<0.001$; $p<0.05$). This is relevant with research from Ritonga & Annum (2019) at the Batunadua Health Center showed that individuals with family history of type 2 diabetes mellitus have a 4.667 times higher risk of developing type 2 diabetes mellitus compared to individuals without a family history of type 2 diabetes mellitus. A study conducted by Novita et al. (2018) in Talang Bakung Village, Jambi City also found that individuals with a family history of type 2 diabetes mellitus had a 4 times higher risk of developing type 2 diabetes mellitus compared to individuals without a family history of type 2 diabetes mellitus. Another study conducted by Haisa et al (2018) at the Benu-Benu Health Center, West Kendari showed that individuals who have a family history of type 2 diabetes mellitus have a 7.429 times higher risk of developing type 2 diabetes mellitus compared to individuals without a family history of type 2 diabetes mellitus ($p = <0.001$; $p <0.05$).

The American Heart Association (AHA) states that several factors can increase the risk of type 2 diabetes mellitus, including a family history of type 2 diabetes mellitus or heredity. Individuals whose parents, relatives or blood relatives have a history of diabetes are also at risk of developing type 2 diabetes mellitus (AHA, 2021). The Centers for Disease Control and Prevention (CDC) also found that if an individual has a mother, father, or sibling who has diabetes, then the individual is likely to be at risk of developing diabetes (CDC, 2023). Individuals who have parents, siblings or biological children with diabetes had a 2 to 6 times greater risk of developing type 2 diabetes mellitus (Diabetes UK, 2023). Beta cells can become

damaged, affecting their ability to detect and stimulate the secretion of insulin. This leads to an individual's susceptibility to developing type 2 diabetes mellitus (Damayanti, 2017).

In general, individuals who have family history with type 2 diabetes mellitus had higher risk of developing type 2 diabetes mellitus compared to individuals without a family history of type 2 diabetes mellitus. Because individuals with a family history of type 2 diabetes mellitus have a genetic predisposition in the development of type 2 diabetes mellitus. This can be seen from the results of the study, where more respondents in the case group had a family history of type 2 diabetes mellitus, namely 37 people (56.1%).

**The Effect of Physical Activity on the Incidence of Type 2 Diabetes Mellitus in Adults Aged 30–60 Years in Medan**

The results of bivariate analysis using simple logistic regression showed that in this study there was a significant effect between physical activity on the incidence of type 2 diabetes mellitus in adults aged 30-60 years in Medan ($p=0.034$; $p<0.05$). This is relevant to the results of research conducted by Nasution et al. (2018) at the Muhammadiyah General Hospital of North Sumatra which shows that individuals who do physical activity less than 3 times per week have a greater risk of developing type 2 diabetes mellitus than individuals with physical activity more than 3 times per week (OR=3.13; 95% CI=1.30–7.55; $p=0.001$).

Another study conducted by Sipayung et al. (2017) in the Padang Bulan Community Health Center in Medan also showed that individuals who had low level of physical activity had a 6.2 times higher risk of suffering from type 2 diabetes mellitus than individuals with moderate and vigorous physical activity (OR=6.245; 95% CI=2.78–14.01, $p<0.05$). Furthermore, research by Gudjinu & Sarfo (2017) in the Volta Region of Ghana found that individuals with less physical activity had a 4.83 times greater risk of type 2 diabetes mellitus compared to individuals who had sufficient physical activity (OR = 4.83; 95% CI = 1.45–16.05, $p<0.05$).

The World Health Organization defines physical activity as any movement of the body produced by the skeletal muscles that requires the expenditure of energy and includes all movements, such as leisure time, travel to and from places, or different occupations of a person, such as walking, cycling, sports, and other physical activities. Regular physical activity is proven to help the body prevent and control non-communicable diseases such as heart disease, stroke, diabetes mellitus, and others. A good physical activity to do for individuals with chronic conditions such as hypertension, diabetes, HIV, and cancer should include at least 150–300 minutes per week of moderate–intensity aerobic physical activity, or 75–150 minutes per week of vigorous–intensity aerobic physical activity, or a combination of moderate and vigorous-

intensity activities. This can help to reduce the long–term effects of health conditions (WHO, 2022a).

Physical inactivity is one of the factors that can increase the risk of developing type 2 diabetes mellitus through insulin resistance. On the contrary, regular physical activity with sufficient intensity can help reduce insulin resistance and improve insulin sensitivity, improve glucose tolerance, help reduce central fat and reduce adipose fat throughout the body, and induce changes in muscle tissue, all of which can help to achieve optimal control of blood glucose levels (Damayanti, 2017).

In non-diabetic individuals, the body will respond to ensure that the muscle energy requirements for exercise are met and glucose homeostasis is also maintained and protected. There is a change in metabolism during exercise due to the uptake of glucose so that muscle glycogen is increased and then converted to lactate to provide an energy substrate. When muscle glycogen is depleted, energy will be provided by glucose from the liver. The main response to exercise is the suppression of insulin secretion, accompanied by metabolic hormones so that glucose will be released from the liver to maintain energy during exercise. In contrast, individuals with type 2 diabetes mellitus usually have sufficient circulating insulin to accelerate the normal metabolic response to exercise and are at risk of hypoglycemia (Dyson, 2003).

Based on the explanation above, the researchers assume that there is a relationship between physical activity with type 2 diabetes mellitus because the majority of respondents do light physical activity such as walking less than 10 minutes in 1 to 2 times a week, and many even do not do physical activity at all as many as 46 people (69,7%) in the case group and 34 people (51,5%) in the control group, resulting in an imbalance between the energy absorbed and that which must be released by the body, which can increase the risk of obesity and decreased insulin sensitivity.

**The Effect of Consumption of Sweetened Foods and Drinks on the Incidence of Type 2 Diabetes Mellitus in Adults Aged 30–60 Years in Medan**

The results of bivariate analysis using simple logistic regression in this research showed that there was a significant effect between consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus in adults aged 30-60 years in Medan ($p=<0.001$; $p<0.05$). The results of this study are in line with research conducted by Siregar et al (2021) which states that individuals who have the habit of consuming sweet foods and drinks have a 1.89 times greater risk of developing type 2 diabetes mellitus compared to those who do not have the habit of consuming sweet foods and drinks (OR = 1.83; 95% CI = 1.00-3.39; $p <0.05$).

In another research conducted by Nurjana & Veridiana (2019) it was found that there was an association between consumption of sweetened foods and drinks and the incidence of type 2 diabetes mellitus ($p<0.05$) and another study conducted by Astuti (2018) in Nyatnyono Village, West Ungaran District, Semarang Regency also stated that individuals who have a habit of consuming sugar-sweetened beverages have an association with the incidence of type 2 diabetes mellitus ($p=0.034$, $p<0.05$).

Through multivariate analysis, it was also found that consumption of sweetened foods and drinks was the most dominant factor affecting the incidence of type 2 diabetes mellitus with an odds ratio (OR) of 7.425. This means that individuals who have the habit of consuming sweetened foods and drinks have a 7.425 times higher risk of developing type 2 diabetes mellitus than individuals without a habit of consuming sweetened foods and drinks.

An unhealthy diet is also one of the modifiable risk factors of type 2 diabetes mellitus. Dietary patterns such as high sugar and low fiber intake can increase the risk of developing several degenerative diseases, especially type 2 diabetes mellitus. Based on the Minister Health’s Regulation No. 30 of 2013 on the listing of information on sugar, salt and total fat content per day, a person is recommended to consume 50 grams of sugar per day (4 tablespoons), 2000 mg of sodium (1 teaspoon) of salt per each person per day and 67 grams of total fat per each person per day (5 tablespoons) (PERMENKES, 2014).

Research published by Chan School of Public Health, Harvard University shows that the habit of consuming 1–2 cans or more of sugary drinks per day can increase the risk of type 2 diabetes mellitus by 26 percent compared to those who rarely consume sugary drinks (Harvard Chan, 2023). Consumption of sugary drinks is detrimental to health because sugary liquids have a lower satiating effect than solid foods with the same number of calories, which can stimulate a high appetite, leading to excessive calorie intake and increased adiposity and, in the long term, increased insulin resistance (Drouin-Chartier dkk., 2019).

In general, the majority of respondents in the case group in this study have the habit of consuming sweet foods and drinks, namely 55 people (83.3%). This is based on the frequency, amount and type of food and drinks that contain a lot of sugar such as drinking coffee or sweet tea with more than 2 tablespoons of sugar plus chocolate bread consumed in a day. This is because sugar is a simple carbohydrate that can be directly absorbed by the body, increasing blood sugar levels and contributing to the development of type 2 diabetes mellitus.

## CONCLUSIONS

Based on the results of this study related to effect of individual, physical activity, and consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus in adults aged 30-60 years in Medan, it can be concluded that there is an effect between individual characteristics such as age and family history, physical activity, and consumption of sweetened foods and drinks on the incidence of type 2 diabetes mellitus. The results also showed that the consumption of sweetened foods and drinks is the most dominant factor affecting the increased risk of developing type 2 diabetes mellitus.

Researchers suggest that health workers should educate the community about the modifiable risk factors for type 2 diabetes mellitus, including physical inactivity and frequent consumption of sweetened foods and drinks so that people are more aware of the dangers of diabetes and take preventive measures. Community health centers are also expected to organize routine screening and health check-ups, especially for groups at high risk of type 2 diabetes mellitus, including those aged more than 45 years and those with a family history of diabetes mellitus. In addition, the public is encouraged to participate in non-communicable disease prevention programs, especially diabetes mellitus prevention, which are carried out by community health centers and carry out regular health checks at health facilities.

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